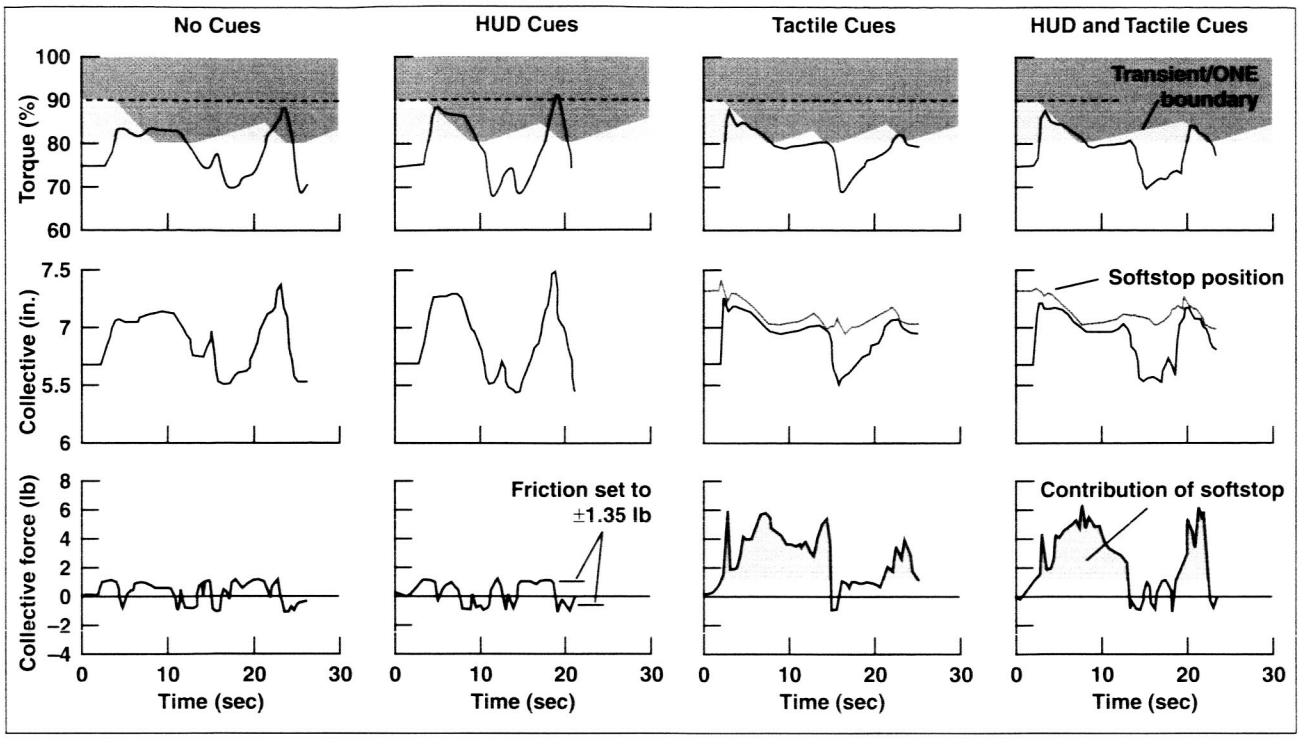

Fig. 2. Sample time-histories from the bob-up task using the active sidestick.

Tilt-Rotor Noise Reduction

Mark D. Betzina, Cahit Kitaplioglu, Khanh Q. Nguyen

Reducing tilt-rotor noise by 12 decibels was a major goal of the Short Haul Civil Tiltrotor (SHCT) program. Blade vortex interaction (BVI) noise reduction was considered a key enabling technology that would allow tilt rotors to land in populated areas such as city centers, thereby relieving congestion at major airports. One of the SHCT objectives was to investigate BVI noise reduction techniques using an isolated, full-scale XV-15 tilt rotor in approach flight conditions in the Ames 80- by 120-Foot Wind Tunnel.

Figure 1 shows two contour plots of noise levels measured on a horizontal plane below and forward of the advancing side of the rotor. This measurement area was chosen to capture the highest BVI noise levels. The center of the rotor is located at the origin, and the arc in the lower left corner represents the location of the rotor blade tips. The left-hand plot shows noise measurements at a high BVI noise condition. The highest noise level, near the center of the measurement area, is 118.5 decibels. The right-hand plot shows the result achieved by tilting the rotor tip-path-plane forward from +3 degrees (aft tilt) to –3 degrees (forward tilt) and applying higher harmonic control (HHC). An HHC system provides high-frequency inputs to the rotor controls, resulting in blade-pitch oscillations at two, three, and four times per revolution on the three-bladed rotor. By making these inputs at the proper phase relative to the blade azimuth position, a large reduction in the rotor's noise signature is produced. The highest noise level for this condition is 102.0 decibels, at a point located near the upper left corner of the measurement area.

Therefore, the peak noise within the measurement area was reduced by 16.5 decibels, surpassing the SHCT program goal of 12 decibels. This noise

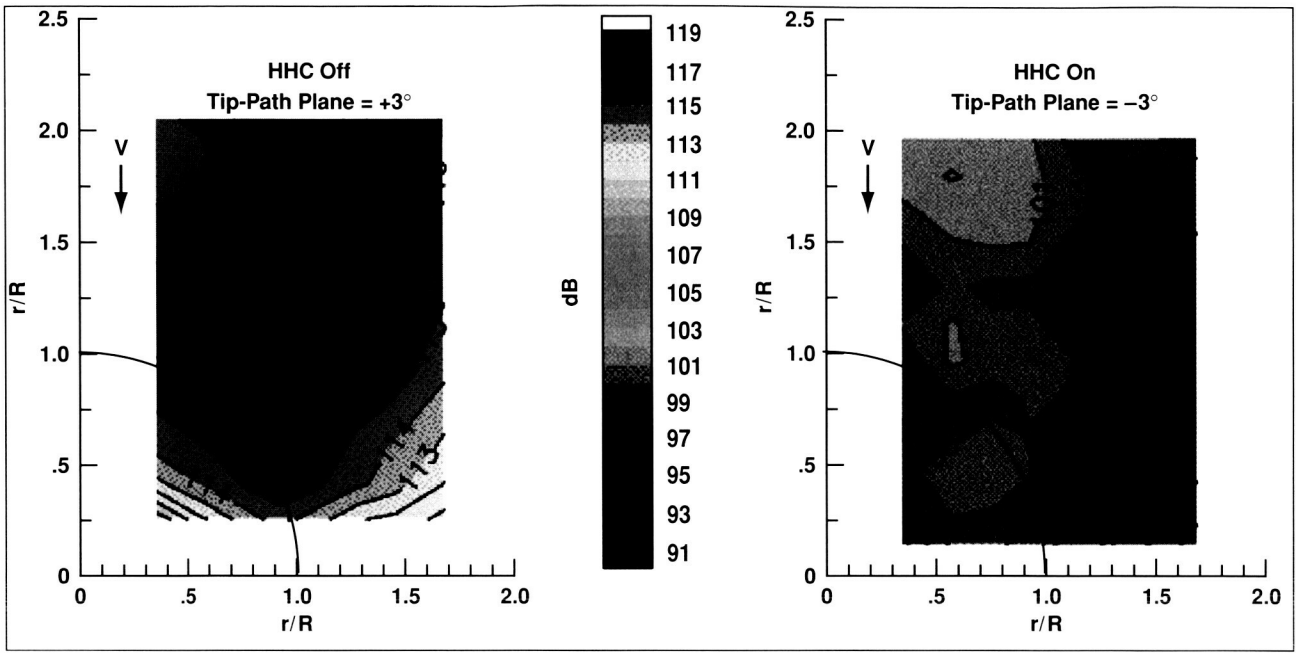

Fig. 1. Noise reduction on a horizontal plane below rotor: velocity = 69 knots, thrust = 5,500 pounds.

reduction was achieved by utilizing a combination of HHC and by changing the rotor's tip-path-plane angle-of-attack. The rotor tip-path-plane angle of a tilt-rotor aircraft can be changed in flight by varying the nacelle tilt angle, wing flap position, and approach glideslope, thus producing a slightly different approach flight condition.

Point of Contact: M. Betzina
(650) 604-5106
mbetzina@mail.arc.nasa.gov